

**SHOBHIT NIRWAN's**  
**DESIGNED**



# **LIGHT REFLECTION AND REFRACTION**

**NEW NOTES FOR CLASS 10 2022 EXAMS**

**Including PYQs in MCQ Format  
NCERT Activities  
Flowchart**

# Light

## Reflection

- Law of Reflection
- Plane Mirror
- Spherical Mirror
- Ray diagrams
- Image formation by
  - concave mirror
  - convex mirror
- Uses of concave & convex mirror
- Mirror formula

## Refraction

- Causes of Refraction
- Refraction through Rectangular glass slab
- Laws of Refraction
- Refractive Index
- Spherical Lens
- Ray diagrams
- Image formation by
  - convex lens
  - concave lens
- Lens formula
- Power of lens

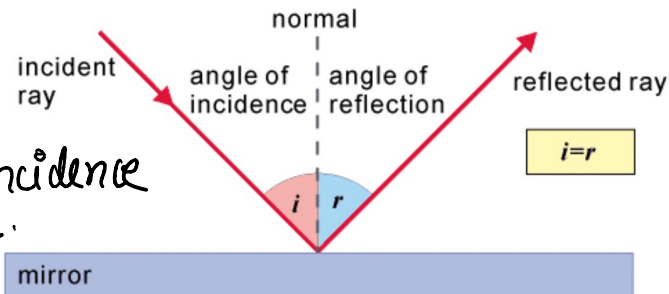
⊛ Light travels in a straight line.

# REFLECTION

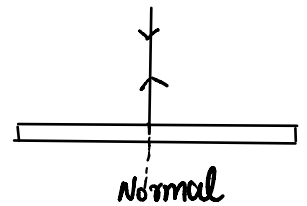
Coming back of light rays to the same medium, when they fall on a surface.

⊛ **Laws of Reflection:**

- (i) Angle of incidence ( $\angle i$ ) = Angle of refl. ( $\angle r$ ).
- (ii) Incident ray, normal at the point of incidence and reflected ray all lie in the same plane.



**K<sup>3</sup>B** ⇒ Any ray of light which is incident normally on a mirror is reflected back along its own path.



- Object - Point of intersection of incident ray is called object.
- Image - Point of intersection of reflected ray is called image.

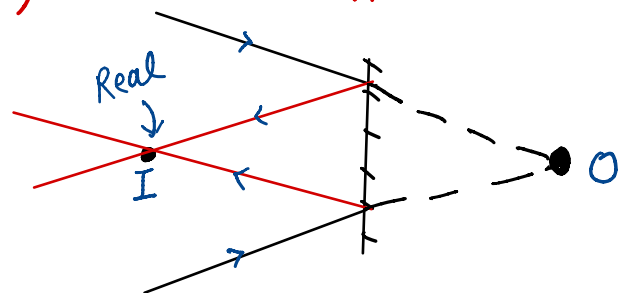
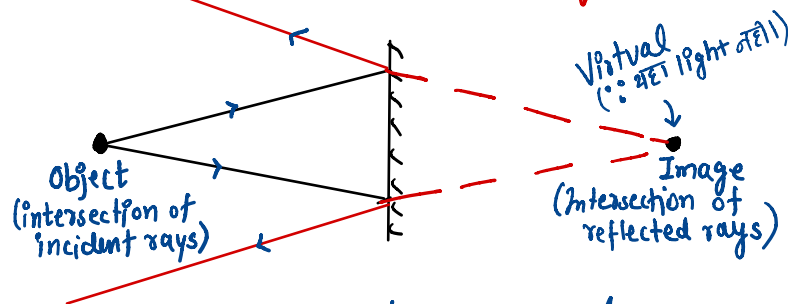
## Real Image

If the light rays coming from a point actually meet after reflection, then image formed is Real.

## Virtual Image

If light rays coming from a point, after reflection does not meet actually but appear to meet at another point then image formed is Virtual.

**Trick:-** जहाँ Light vo Real, जहाँ नहीं वो Virtual.



Red → Reflected rays  
Black → Incident rays

## Plane Mirror

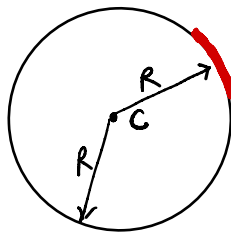
- Object and image are equidistant from the plane mirror.
- If object is real then image will be virtual and vice-versa.
- Image is laterally inverted i.e. left seems to be right and vice-versa.
- Size of image is equal to size of object.
- Uses → looking glass, periscopes etc.



# Spherical Mirror

↳ Whose reflecting surfaces are spherical:-

(ये mirror एक sphere के ही part होते हैं।)



for example  
यहाँ से काट कर  
निकाल लिया।

↳ तो अब spherical mirror देखते ही एक imaginary sphere दिमाग में ले आना और मान लेना कि उसी sphere से वो mirror बना है।

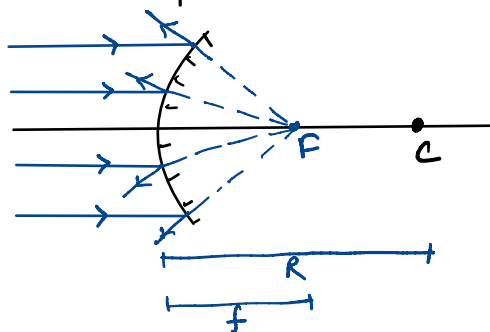
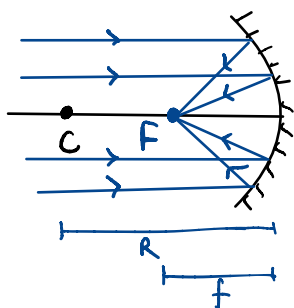
गुफा  
CONCAVE  
MIRROR

Reflecting surface

CONVEX  
MIRROR

Reflecting surface

- **Radius of Curvature:** Radius of curvature of a spherical mirror is the radius of imaginary sphere of which, mirror is part.
- **Centre of Curvature:** Centre of that imaginary sphere of which, mirror is part.
- **Pole:** It is the mid-point of its reflecting surface. Symbol  $\rightarrow P$ .
- **Principal Axis:** line joining pole and centre of curvature.
- **Focus (F):** A point on principal axis of the mirror at which the light rays coming parallel to principal axis, after reflection actually meet.



focus of concave  $\rightarrow$  Real  
convex  $\rightarrow$  Virtual

focal length (f)  $\rightarrow$  Distance between pole and focus.

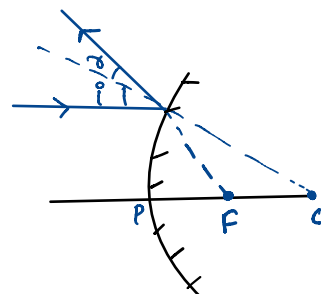
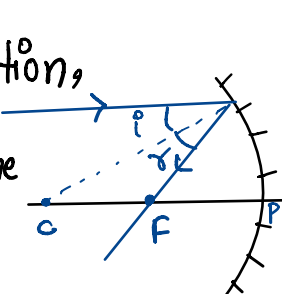
in mirror only  $\Rightarrow f = \frac{R}{2}$

- **Aperture:** diameter of reflecting surface of spherical mirror.

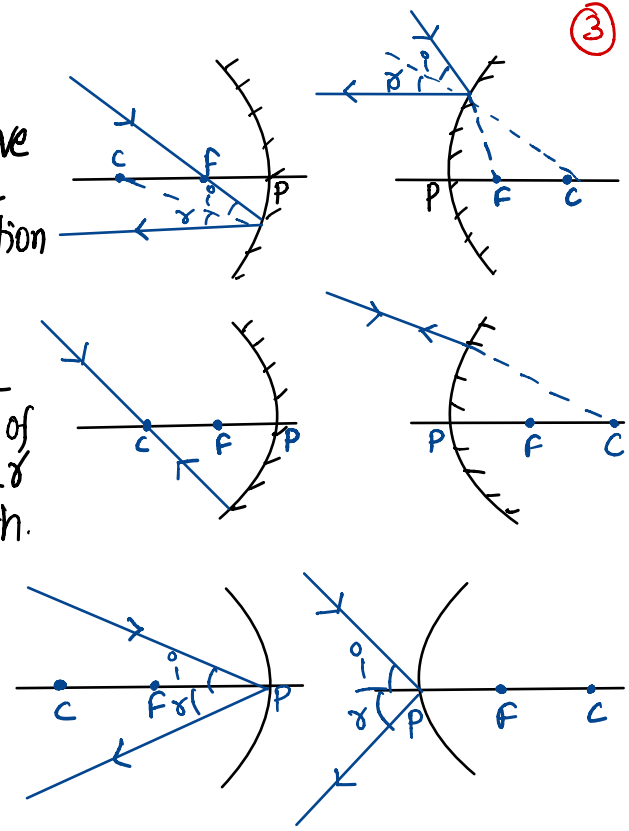
## RAY DIAGRAMS

# Some Rules:-

- A ray parallel to principal axis, after reflection, will pass through the principal focus in case of a concave mirror or appear to diverge from the principal focus in case of a convex mirror.



- A ray passing through principal focus of a concave mirror or a ray which is directed towards the principal focus of a convex mirror, after reflection will emerge parallel to principal axis.
- Ray passing through centre of curvature of a concave mirror or directed in the direction of centre of curvature of a convex mirror, after reflection, is reflected back along same path.
- The incident and reflected rays make equal angles with principal axis.



## # IMAGE FORMATION BY CONCAVE MIRROR:-



Image formed by Concave Mirror:-

Position of object	Position of image	Nature of image	Ray diagram
(i) At infinity	At focus	Real, Inverted, and diminished	
(ii) Beyond C	Between F and C	Real, Inverted and diminished	
(iii) At C	At C	Real, Inverted and same size	
(iv) Between F and C	Beyond C	Real, Inverted and enlarged	
(v) At F	At Infinity	Real, Inverted and highly enlarged	
(vi) Between F and P	Behind the mirror	Virtual, enlarged and erect image	

Here u = Distance of object  
v = Distance of image

## Uses of concave mirror:-

↳ shaving mirror, torch, dentists, in solar furnace.

Position of object	Ray diagram	Position of image	Nature and Size of image
At infinity		At the principal focus	Virtual, erect and extremely diminished
Between infinity and the pole (i.e. at finite distance)		Between the principal focus and the pole	

## # By Convex mirror:-



↳ Here we consider only two positions of the object. firstly, when object is at infinity and the second position is, when object is at a finite distance from mirror.

## Uses of Convex Mirror:

- Rear view mirrors in vehicles because they always give an exact image and have wider field of view as they are curved outwards.
- Big convex mirrors used as shops security mirrors.

गाइडी का वीरशा!



# # Sign-convention :-

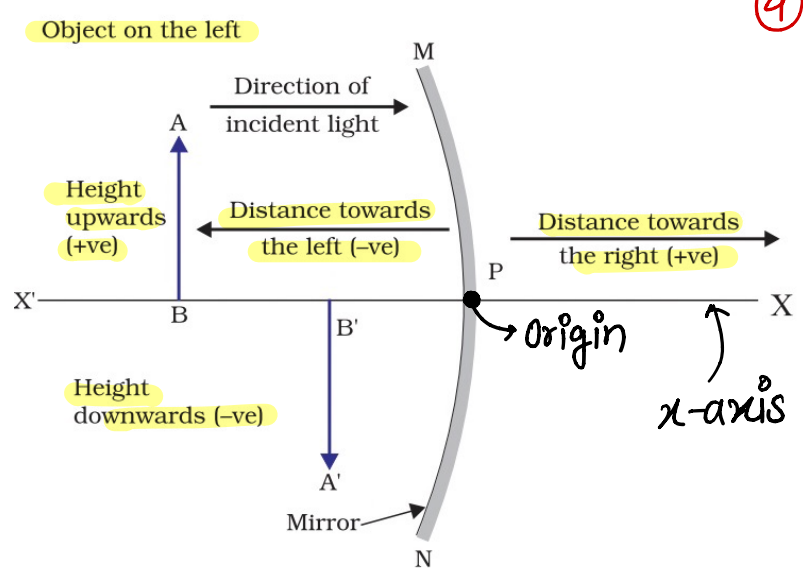
- o Pole is origin.
- o Principal axis is x-axis

## MIRROR FORMULA

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

[with sign]

- $f \Rightarrow$  x-coordinate of focus
- $v \Rightarrow$  x-coordinate of image
- $u \Rightarrow$  x-coordinate of object



Magnification (m): Gives the relative extent to which the image of an object is magnified with respect to object size.

$$m = -\frac{v}{u} = \frac{h_i}{h_o}$$

$h_i$  = height of Image  
 $h_o$  = height of Object

Imp:- An object is placed at a distance of 12cm in front of a concave mirror. It forms a real image four times larger than the object. Calculate the distance of image from the mirror.

K<sup>3</sup>B

$m = -ve \rightarrow$  Inverted.  
 $m = +ve \rightarrow$  Erect

Object	Image
RO	RI
VO	VI
RO	VI
VO	RI

Inverted  
Erect

Trick:- 2 फरक के लिए  
"same-same inverted"  
i.e. RO RI या VO VI

2 फरक दोनो रट लो (Trick है जो काम आएगी)

Solution of (Q):- Given:-  $u = -12$  cm [as we know object is always on left  $\therefore$  -ve sign]

$m = 4$  times [but m का sign??]

अब यहाँ Trick लागेगी उस वाली।

as object is "placed"  $\rightarrow \therefore$  R.O.

& given R.I.

R.O. & R.I.  $\rightarrow$  same-same  $\Rightarrow$  inverted!

and we know for inverted,  $m = -ve$

- R.O. - Real Object
- R.I. - Real Image
- V.I. - Virtual Image
- V.O. - Virtual Object

$$\therefore m = -4$$

[Red pen वाला part rough में करना, it is not for boards, because ये JEE की Thick है ॐ]

(5)

$$\text{as, } m = -\frac{v}{u} \Rightarrow \therefore -\frac{v}{u} = -4$$

$$\frac{-v}{(+12)} = -4$$

$$\boxed{v = -48 \text{ cm}}$$

LP: An object is placed at a distance of 8cm from a convex mirror of focal length 12cm. Find position of image.

sol: given,  $u = -8 \text{ cm}$   
 $f = +12 \text{ cm}$   
 using mirror formula,

$$v = ?$$

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{v} + \frac{1}{(-8)} = \frac{1}{12}$$

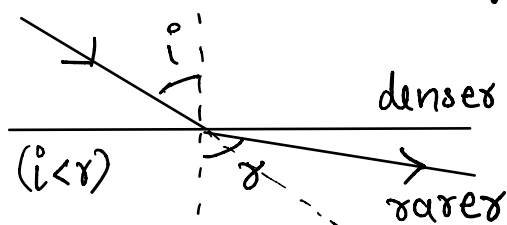
$$\Rightarrow \frac{1}{v} = \frac{1}{12} + \frac{1}{8} \Rightarrow \frac{2+3}{24} \Rightarrow \frac{5}{24}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{4.8} \Rightarrow \boxed{v = 4.8 \text{ cm}}$$

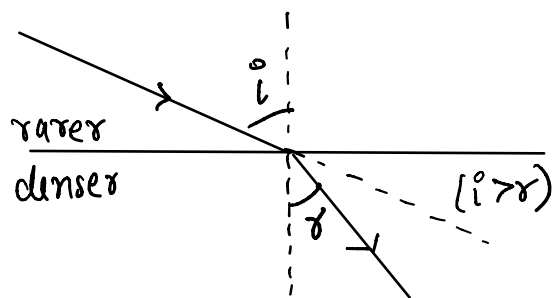
[हमें  $v$  का sign की चिंता नहीं करनी वो automatically सही sign आएगा।]

## REFRACTION

Change in path of a light ray as it passes from one medium to another medium is called Refraction of light.



When light ray goes from denser to rarer medium, it bends away from normal.



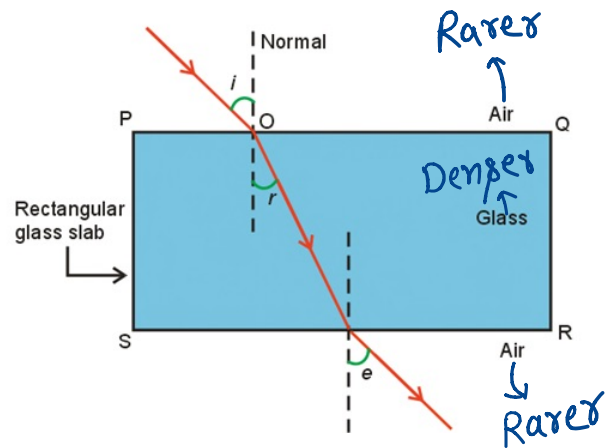
When light rays goes from rarer to denser medium it bends towards the normal.

Cause of Refraction? → As we know speed of light is different in different media, i.e. more in rarer medium and comparatively less in denser medium. So, when light enters a denser medium, its speed reduces and it bends towards the normal and when it enters rarer medium, its speed increases and it bends away from the normal.

## # Refraction through a Rectangular Glass Slab:-

$i$  = angle of incidence  
 $r$  = angle of refraction  
 $e$  = angle of emergence

- Angle of incidence = Angle of emergence,  $\angle i = \angle e$
- If the incident ray falls normally to the surface of glass slab, then there is no bending of ray of light; i.e. it goes straight.



## # LAWS OF REFRACTION:-

- The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
- The ratio of sine of angle of incidence to the sine of angle of refraction for light of given colour is constant for a given pair of media (Snell's Law). It is expressed as:

$$\frac{\sin i}{\sin r} = \mu = \text{constant} \quad [\mu \rightarrow \text{refractive index}]$$

# **Refractive Index**: The extent of change in direction that takes place in a given pair of media is expressed in terms of refractive index.

$\mu_2$  represents refractive index of medium 2 with respect to medium 1, when light is going from medium 1 to medium 2.

$$\mu_2 = \frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r}$$

- The refractive index of a medium with respect to vacuum is called absolute refractive index of medium.

for glass/water pair  $\Rightarrow \mu_{wg} = \frac{\mu_g}{\mu_w}$

[कुछ ना दिया हो तो  
w.r.t vacuum (a)  
ही लेंगे।]

- If question is related to speed:

$$\mu = \frac{c}{v}$$

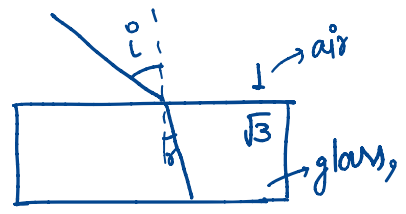
$\rightarrow$  speed of light in vacuum/air  
 $\rightarrow$  speed of light in medium

for eg,  $\mu_{wg} = \frac{\text{velocity of light in air}}{\text{velocity of light in glass}} = \frac{c}{v_g}$

or,  $\mu_{w} = \frac{c}{v_w}$  (water)

LP: Calculate angle of incidence of light ray incident on surface of a plastic slab of refractive index  $\sqrt{3}$ , if angle of refraction is  $30^\circ$ .

sol:



given,  $r = 30^\circ$

light is going from air to glass

$$\therefore \mu_g = \frac{\mu_g}{\mu_a} = \frac{\sin i}{\sin r}$$

$$\Rightarrow \frac{\sqrt{3}}{1} = \frac{\sin i}{\sin 30^\circ} \left( \frac{1}{2} \right)$$

$$\Rightarrow \sin i = \frac{\sqrt{3}}{2}$$

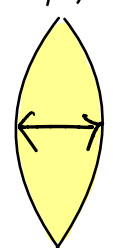
$$\therefore i = 60^\circ$$

(K3B)

जब speed given होगी तो "speed" वाला formula करना "sin" वाला।

## SPHERICAL LENS

↳ A transparent material bound by two surfaces, of which both surfaces are spherical, forms a lens.

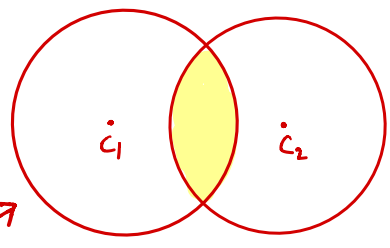


Thick at middle  
↓  
Convex / Converging lens



Thin at middle  
↓  
Concave / Diverging lens

(K3B) Lens कैसे बनते हैं?

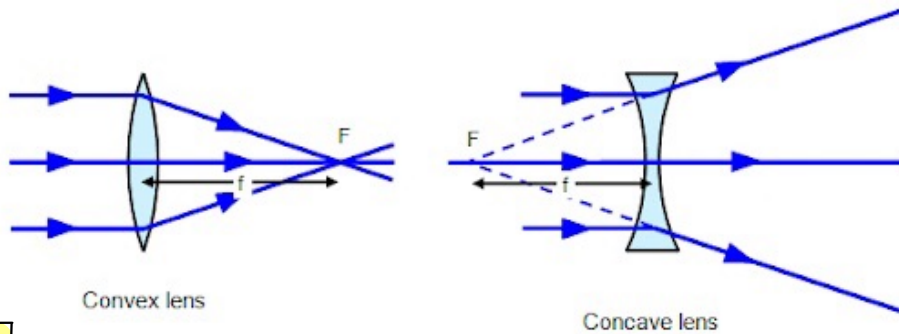


→ sphere

→ दो spheres को जोड़कर बना हुआ मान सकते हैं। (Just an imagination for solving questions easily)

- **Centre of curvature (c)**: A lens has two spherical surfaces. Each surface forms a part of a sphere. The centre of these spheres are called centre of curvature. [अथ  $C_1$  &  $C_2$ ] [or  $2F_1$  &  $2F_2$ ]
- **Principal Axis**: An imaginary straight line passing through the two centres of curvature of a lens is called its principal axis.
- **Optical centre (o)**: Central point of a lens is called optical centre.
- **Aperture**: Effective diameter of the circular outline of a spherical lens is called its aperture.
- **Principal focus (F)**: The point where the rays parallel to principal axis after

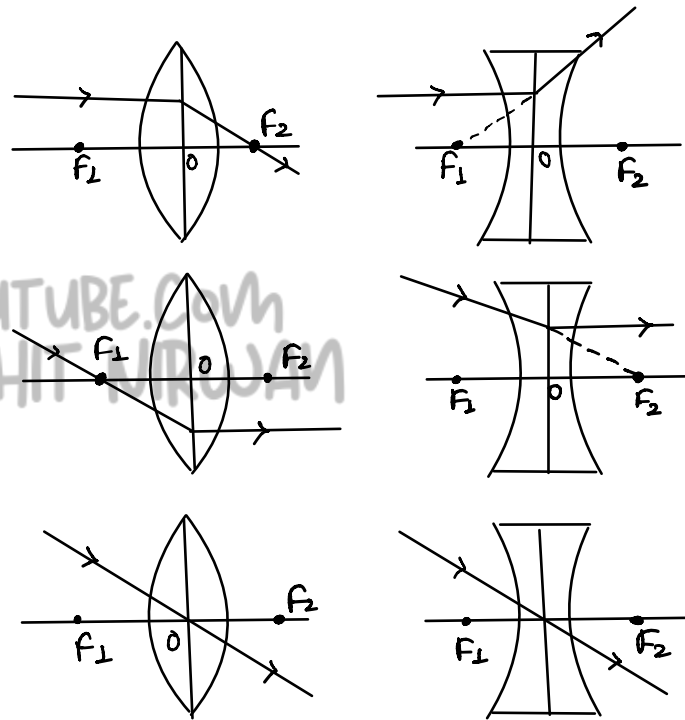
- refraction meet is called principal focus. A lens has two principal foci.
- o **Focal length (f)**: The distance of principal focus from optical centre.



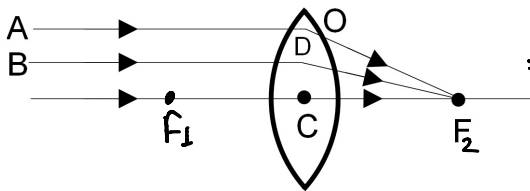
## RAY DIAGRAMS

### # Rules:

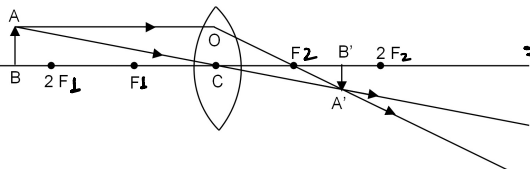
- o Rays which are parallel to principal axis, after refraction will pass through principal focus in case of convex lens and will appear to be coming from principal focus in case of concave lens.
- o Ray passing through or directed to the focus will emerge parallel to principal axis.
- o Ray directed to optical centre will emerge out undeviated.



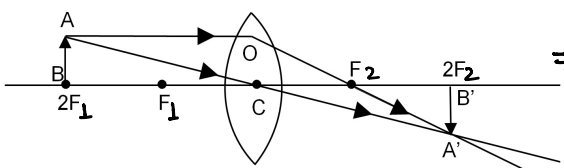
### # Image formation by Convex lens



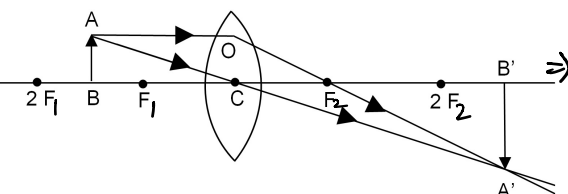
object → at infinity  
 image → At  $F_2$   
 Nature → Real, inverted & diminished



object → Beyond  $2F_1$   
 image → between  $F_2$  and  $2F_2$   
 nature → real, inverted & diminished

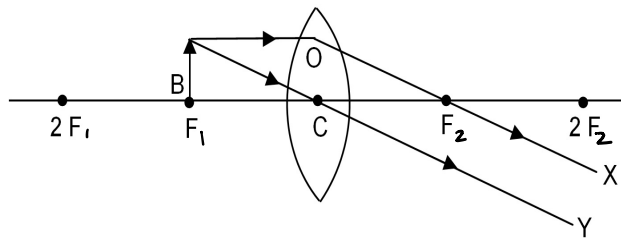


object → At  $2F_1$   
 image → At  $2F_2$   
 nature → Real, inverted & same size as of object.

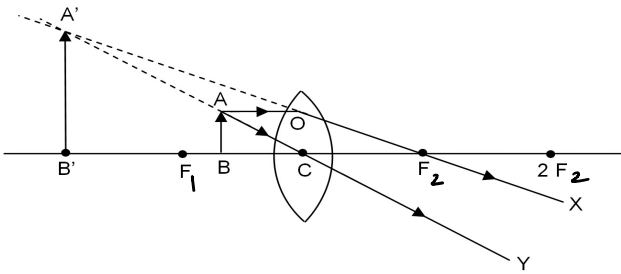


object → Between  $F_1$  and  $2F_1$   
 image → Beyond  $2F_2$   
 nature → Real, inverted & magnified.

→  $2F_1$  means  $F_1$  ki double length.



⇒ Object → At  $F_1$   
 image → at infinity  
 nature → Real, inverted & magnified.



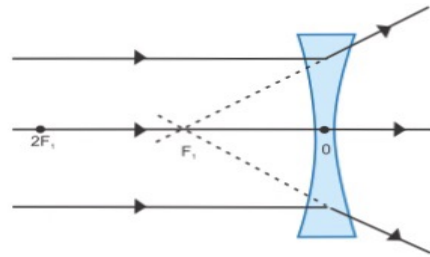
⇒ object → Between lens and  $F_1$   
 image → On same side of lens as object  
 nature → virtual, erect and magnified.

## # Image formation by Concave lens:-

### 1) When object is placed at infinity

Image is :

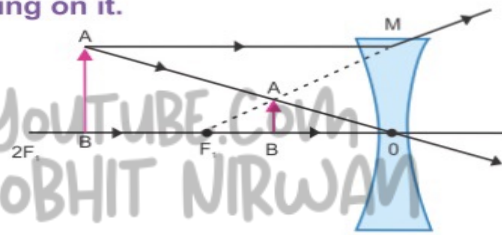
- formed at  $F_1$
- virtual and erect
- highly diminished



### 2) A concave lens diverges all rays falling on it.

Therefore for all positions, image is :

- on the same side of object
- virtual and erect
- diminished



## Lens Formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

(with sign)

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

sign convention is same as that for mirrors  
 Also, In convex lens focal length → +ve  
 and in concave → -ve

$h_i$  = height of image  
 $h_o$  = height of object

[Pg-4) की K3B lens पर ही applicable है]

## # POWER OF LENS (P):

Ability of a lens to converge or diverge light rays is called power (P) of the lens.

$$P = \frac{1}{f(\text{in m})}$$

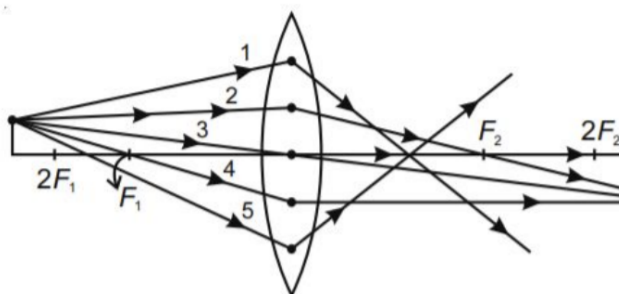
$f$  → focal length in metre

SI Unit → [D] (called Dioptre =  $\text{m}^{-1}$ )

Power for  $\left\{ \begin{array}{l} \text{convex lens} \rightarrow +ve \rightarrow \because f \rightarrow +ve \\ \text{concave lens} \rightarrow -ve \rightarrow \because f \rightarrow -ve \end{array} \right.$

# PREVIOUS YEAR QUESTIONS

- To find the focal length of a concave mirror, Sita should choose which one of the following :  
 (a) A mirror holder and screen holder  
 (b) A screen holder and a scale  
 (c) A mirror holder, a screen holder and a scale  
 (d) A screen, a mirror, holders for them and a scale [1M,2011]
- By using a convex lens, a student obtained a sharp image of his classroom window grill on a screen. In which direction should he move the lens to focus a distant tree instead of the grill?  
 (a) Towards the screen  
 (b) Away from the screen  
 (c) Very far away from the screen  
 (d) Behind the screen [1M,2011, 2016, 2017]
- Out of the five incident rays shown in the figure find the three rays which are obeying the laws of refraction and may be used for locating the position of the image formed by a convex lens: [1M,2013, 2014]



- 1, 2 and 3
  - 2, 3 and 4
  - 3, 4 and 5
  - 1, 2 and 4
- What is the range of wavelength of visible light? [1M, 2018]  
 a) 480 to 700 nanometers  
 b) 320 to 750 nanometers  
 c) 280 to 500 nanometers  
 d) 380 to 700 nanometers
  - The refractive indices of glass and water with respect to air are  $\frac{3}{2}$  and  $\frac{4}{3}$  respectively. If the speed of light in glass is  $2 \times 10^8$  m/s, find the speed of light in water. [2M,2016]  
 a)  $2.15 \times 10^8$  m/s  
 b)  $2.25 \times 10^9$  m/s  
 c)  $2.25 \times 10^8$  m/s  
 d)  $1.25 \times 10^8$  m/s

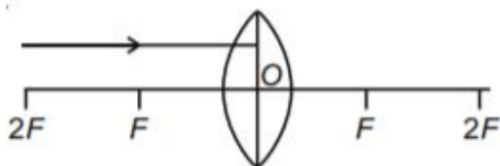
6. What is the minimum number of rays required for locating the image formed by a concave mirror for an object? [2M,2009]

- a)1
- b)2
- c)3
- d)4

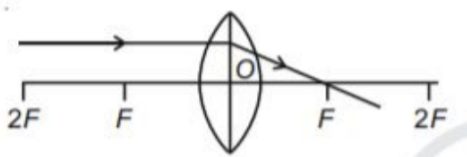
Ans.

- 1 d
- 2 a
- 3 b
- 4 d
- 5 c
- 6 b

7. Draw the given diagram in your answer book and complete it for the path of ray of light beyond the lens. [1M,2009]



Ans.



8. Explain why a ray of light passing through the centre of curvature of a concave mirror gets reflected along the same path. [1M,2010]

Ans. A ray of light passing through the centre of curvature of a concave mirror falls on the mirror along the normal to the reflecting surface. Hence, it gets reflected along the same path following the laws of reflection.

9. Why does a ray of light bend when it travels from one medium into another? [1M,2009]

Ans. Light has different speeds in different media and it takes such a path of propagation for which time taken is minimum.

5. What is the nature of the image formed by a concave mirror if the magnification produced by the mirror is +3? [1 M,2010]

Ans 5. The nature of the image formed by a concave mirror if the magnification produced by the mirror is +3 is virtual, erect and magnified.

10. A student obtained a sharp image of the grills of a window on a screen using a concave mirror. His teacher remarked that for getting better results a well lit distance

object (preferably the Sun) should be focused on the screen. What should be done for this purpose? [1M,2012, 2013]

Ans. The screen is moved away from the mirror so as to focus the object for a fixed position of the mirror and the object.

11. An object is placed at a distance of 15 cm from a concave lens of focal length 30 cm. List four characteristics (nature, position, etc.) of the image formed by the lens. [1M,2017]

Ans. Given,

$u = -15$  cm (It is to the left of the lens)

$f = -30$  cm (It is a concave lens)

Using the lens formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$v = -10 \text{ cm}$$

The negative sign of the image distance shows that the image is formed on the left side of the concave mirror. Thus, the image formed by a mirror is virtual, erect and on the same side as the object.

12. Write two different uses of concave mirrors. [1M,2017]

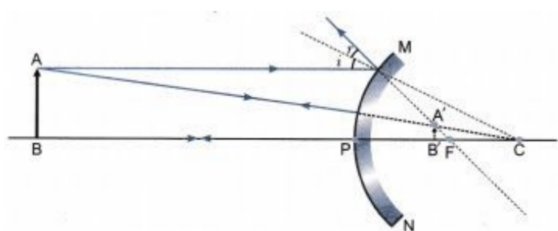
Ans. Concave mirrors are used in reflecting telescopes. They are also used to provide a magnified image of the face for applying make-up or shaving.

13. What makes things visible? [1M]

Ans. Objects are visible due to reflection. Light gets reflected from the object and makes it visible.

14. If the image formed by a spherical mirror for all positions of the object placed in front of it is always erect and diminished, what type of mirror is it? Draw a labelled ray diagram to support your answer [2M,2018]

Ans.



15. List four precautions which a student should observe while determining the focal length of a given convex lens by obtaining an image of a distant object on a screen. [2M,2019]

Ans. (i) The lens should be held in vertical position with its face parallel to the screen.

(ii) A clear and sharpest image of the distant object should be obtained by suitably adjusting the position of the lens.

(iii) At least three observations should be taken.

(iv) Measure the distance between the convex lens and the screen carefully.

16. List four properties of the image formed by a concave mirror when an object is placed between the focus and pole of the mirror. [2M,2012]

Ans. When an object is placed between the focus and the pole of a concave mirror, the image formed is

- (i) Virtual
- (ii) Enlarged
- (ii) Behind the mirror
- (iv) Erect

17. A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal. Why? [2M]

Ans. The ray of light bends towards the normal. When a ray of light enters from an optically rarer medium (having low refractive index) to an optically denser medium (having high refractive index), its speed slows down and it bends towards the normal. Since water is optically denser than air, a ray of light entering from air into water will bend towards the normal.

18. Differentiate a real image from a virtual image giving two points of difference. [2M]

Ans.

Real Image	Virtual Image
Either reflection or refraction of light is responsible for obtaining the real image.	The image is obtained when the light from an object strikes the particular point.
To obtain a real image on the screen, the rays of light must intersect with each other.	The image is not obtained on the screen as the rays of lights do not intersect as they are imaginary.

19. Name the type of mirror used in the design of solar furnaces. Explain how high temperature is achieved by this device. [2M,2016]

Ans. (i) Concave mirror/ converging mirrors

(ii) When a solar furnace is placed at the focus of a large concave mirror/reflector, it focuses a parallel beam of light on the furnace, consequently a high temperature is achieved after some time.

20. State the laws of refraction of light. Explain the term 'absolute refractive of a medium' and write an expression to relate it with the speed of light in vacuum. [3M,2018]

Ans. Laws of Refraction of light: Refraction of light follows the following two laws :

**First Law** : The incident ray, the normal to the transparent surface at the point of incidence and the refracted ray, all lie in one and the same plane.

**Second Law** : The ratio of sine of the incidence angle to the sine of the refracted angle of the medium is called refractive index. It is denoted by  $N$ .

i.e.,  $\sin i / \sin r = n$

Refractive index of the second medium with respect to the first medium is denoted by  ${}_2n_1$ .

Thus, eq. (i) can be written as

$${}_2n_1 = \sin i / \sin r$$

This law is called **Snell's law** as it was stated by Prof. Willebrord Snell (Dutch mathematician and astronomer).

**Absolute Refractive index** : Absolute refractive index of a medium is defined as the ratio of the speed of light in vacuum or air to the speed of light in the medium. It is denoted by  $n$ .

$$n = \frac{c}{v}$$

Then,

It has no unit.

21. The image formed by a spherical mirror is real, inverted and is of magnification -2. If the image is at a distance of 30 cm from the mirror, where is the object placed? Find the focal length of the mirror. List two characteristics of the image formed if moved 10 cm towards the mirror

[3M,2016]

Ans. Given: Magnification,  $m = -2$

Distance of the image,  $v = -30$  cm

Magnification,  $m = -v/u$

$$u = -v/m = -(-30)/(-2)$$

Therefore,  $u = -15$  cm

Substituting these values in the mirror formula

$$1/f = 1/v + 1/u = 1/(-30) + 1/(-15)$$

$$1/f = -1/10$$

Therefore,  $f = -10$  cm

When the object is moved 10 cm towards the mirror the new position of the object is

$$u' = -(15-10) = -5$$

Substituting the new value in the mirror formula

$$1/f = 1/v + 1/u$$

$$1/v' = 1/f - 1/u = 1/10 - 1/(-5)$$

$$1/v' = 1/10$$

Therefore,  $v' = 10$  cm

Thus, the image is located 10 cm behind the mirror.

$$m' = v'/u' = -10/(-5)$$

And magnification,

$$m' = 2$$

Since magnification is positive the image is erect and virtual.

Thus, the image is erect, virtual and magnified in nature.

22. An object of height 5 cm is placed perpendicular to the principal axis of a concave lens of focal length 10 cm. If the distance of the object from the optical centre of the lens is 20 cm, determine the position, nature and size of the image formed using the lens formula. [3M,2015]

Ans. Height of the object is  $h = 5$  cm

Focal length of concave lens is  $f = -10$  cm

Object distance is  $u = -20$  cm

From lens formula, we have

$$1/f = 1/v - 1/u$$

$$1/v = 1/f + 1/u = 1/(-10) + 1/(-20)$$

$$1/v = 1/(-10) - 1/20 = -3/20$$

$$v = -20/3$$

Hence, the image is situated at a distance  $-20/3$  cm from the lens on the same side as the object. So, the image is virtual.

Magnification produced by a lens is

$$m = h'/h = v/u$$

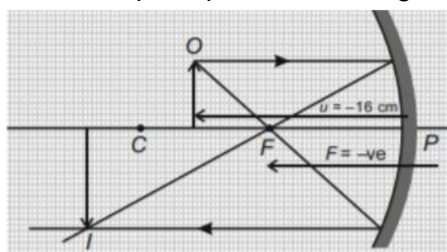
$$h' = (v/u)h = [-20/(3 \times (-20))]5 = 5/3 = 1.67 \text{ cm}$$

Hence, the image is virtual and erect.

23. List the sign conventions for reflection of light by spherical mirrors. Draw a diagram and apply these conventions in the determination of focal length of a spherical mirror which forms a three times magnified real image of an object placed 16 cm in front of it. [5M,2012]

Ans. Sign conventions of spherical mirror :

- (i) Object is always placed to the left of the mirror.
- (ii) All distances are measured from the pole of the mirror.
- (iii) Distances measured in the direction of the incident ray are positive and the distances measured in the direction opposite to that of the incident ray are negative.
- (iv) Distances measured along the-axis (upwards) above the principal axis are positive and that measured along the-axis (downwards) below the principal axis are negative.



Given that:  $u = -16\text{cm}$  and  $m = 3$

We know that magnification for a spherical

Mirror,  $m = -(v/u) = h_2/h_1$

$$\text{i.e., } -(v/u) = 3$$

$$v = -3u$$

Using mirror formula:

$$1/f = 1/u + 1/v$$

$$1/f = 1/(-16) + 1/(-3 \times -16)$$

$$1/f = 48/(-4)$$

$$f = -12 \text{ cm}$$

Negative sign of focal length implies that the focal length is being measured against the direction of incident light and it is a concave mirror.

24. What is meant by power of a lens? Define its SI unit. You have two lenses A and B of focal lengths  $+10$  cm and  $-10$  cm, respectively. State the nature and power of each lens. Which of the two lenses will form a virtual and magnified image of an object placed 8 cm from the lens? Draw a ray diagram to justify your answer.

[5M,2015, 2018]

Ans 30. The power of a lens is defined as the reciprocal of its focal length. It is

represented by the letter  $p$ .

The power  $p$  of a lens of focal length  $f$  is given as

$$p = 1/f$$

The SI unit of power is dioptre (D).

Given:

Focal length of lens A,  $F_A = +10 \text{ cm} = +0.1 \text{ m}$

Focal length of lens B,  $F_B = -10 \text{ cm} = -0.1 \text{ m}$

To calculate the power of lens A:

The power of lens A,

$$p = 1/f_A$$

$$p = 1/0.1$$

$$p = +10 \text{ D}$$

The positive sign indicates that it is a converging or convex lens.

To calculate the power of lens B :

The power of lens B,

$$p = 1/f_B$$

$$p = 1/(-0.1)$$

$$p = -10 \text{ D}$$

The negative sign indicates that it is a diverging or concave lens.

In a convex lens, when the object is placed between the pole and focus, the image formed is always virtual and magnified.

On the other hand, a concave lens produces a virtual, erect but diminished image. Here the object is placed 8 cm from the lens which is at a distance less than the focal length, i.e. less than 10 cm. Thus, the 8 cm position of the object placed in front of the convex lens will produce a virtual and magnified image. The diagram for the same is as shown below :

